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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 18

Application Number: 08/893,917
Filing Date: July 11, 1997
Appellants: Littau,Karl A.; Chen,Chiliang L.; Vasudev,Anand

Chung-Pok Leung of Townsend and Townsend and Crew, LLP
For Appellant

EXAMINER'S ANSWER

This is in response to appellant's brief on appeal filed September 12, 2000.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The amendment after final rejection filed on May 9, 2000 has been entered.

(5) Summary of Invention

The invention is directed to a method and apparatus for removing residue from a substrate processing chamber by forming a plasma remote from the processing chamber. The method further includes means for combining the plasma and a nonplasma "diluent gas flow" at a position anterior to the processing chamber, and, subsequently, delivering the mixture to the processing chamber.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's brief includes a statement that claims 1-21 do not all stand or fall together and provides reasons as set forth in 37 CFR 1.192(c)(7) and (c)(8). The Examiner agrees with the grouping of claims.

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

The following is a listing of the prior art of record relied upon in the rejection of claims under appeal.

5,328,558	Kawamura	July 12, 1994
5,403,434	Moslehi	April 4, 1995
5,302,803	Stevens et al	April 12, 1994

(10) Grounds of Rejection

The following grounds of rejection are applicable to the appealed claims:

Claims 1-4, 6, 8, 9, 11-15, 21 are rejected under 35 U.S.C. 102(b). This rejection is set forth in prior Office action, Paper No. 11.

Claims 1-15, 21 are rejected under 35 U.S.C. 102(b). This rejection is set forth in prior Office action, Paper No. 11.

Claims 16-20 are rejected under 35 U.S.C. 103(a). This rejection is set forth in prior Office action, Paper No. 11.

(11) Response to Arguments

Claim Group 1 - Page 7

Appellant's arguments:

"Applicants respectfully assert that claims 1-3 are novel and patentable over Kawamura and Moslehi because, for instance, they do not disclose or suggest mixing a flow of reactive radicals and a nonplasma diluent gas flow anterior to a chamber to form a gas-radical mixture, and flowing the gas-radical mixture into the chamber in a method of removing residue from a substrate processing chamber, as recited in claim 1 from which claims 2 and 3 depend."

Examiner's Response to Arguments:

1. Appellant's arguments filed September 12, 2000 (paper 17) have been fully considered but they are not persuasive. Specifically, the appellant's argument that Kawamura does not disclose or suggest a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture (page 7, paper 17) is inaccurate. As cited in the final action on the merits, Kawamura describes a dry etching **apparatus using a method** for etching silica film with the use of a gas (column 1, lines 1-2). Specifically, the limitations set forth in the rejected claims are explicitly detailed by Kawamura:

a. **Remote plasma formation** (column 3, lines 50-60) **relative to substrate processing chamber** (Column 4, lines 13-18). The Merriam-Webster's Collegiate Dictionary definition

of "anterior" (see below) supports the application of the Kawamura reference to the stated rejection. The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

b. ***Diluent gas flow (column 3, lines 59-66) forming a mixture of reactive radical plasma and nonplasma diluent gas anterior to a wafer processing chamber (Column 4, lines 13-18).*** The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Kawamura reference to the stated rejection. The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

Moslehi:

c. ***Diluent gas flow*** (column 11, lines 37-44) **forming a mixture of reactive radical plasma gas and nonplasma diluent gas anterior to a wafer processing chamber** (Column 9, lines 10-17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

d. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[1]

Claim Group 2 - Page 8

Appellant's arguments:

"Applicants believe that claim 4 is allowable. Further, claim 4 recites that the nonplasm diluent gas flow comprises an inert gas. In Kawamura, the Ar gas is not mixed with the plasma activated species anterior of the chamber to form a gas-radical mixture. In Moslehi, the inert gases are plasma-activated with the digermane gas and additives and flowed into the chamber in one case, and are plasma-activated and flowed into the chamber separately from the nonplasma digermane gas and additives in the other case. There is no mixing of a nonplasma inert gas with reactive radicals to form a gas-radical mixture anterior of the chamber."

Examiner's Response to Arguments:

e. By Kawamura, plasma gas (column 5, lines 65-69) and a nonplasma inert gas (Argon, column 6, lines 15-17) mixed anterior at buffer chamber 30 (Figure 1) thus forming gas-radical mixture (responsive to first paragraph, Page 8, Paper 17). The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

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[1]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

f. By Moslehi, there is demonstrated a "T" in the piping between a "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

Claim Group 3 - Page 8

Appellant's arguments:

"Further, claim 5 recites that the nonplasm gas. In Moslehi, H_2 is plasma-activated with the remaining gases and flowed into the chamber in one case, and is introduced into the chamber separately from the plasma-activated inert gases. There is no mixing of a nonplasma reduction gas with reactive radicals to form a gas-radical mixture anterior of the chamber."

Examiner's Response to Arguments:

g. By Moslehi, **diluent gas flow comprises a nonplasma reduction gas, in this case hydrogen** (column 11, lines 37-44) is taught with reference to Figure 1: items 20 and the "nonplasma" piping T.

h. *With regards to Moslehi teaching the H_2 reduction gas as "plasma activated" - appellant is directed to column 12, line 1

i. By Moslehi, there is demonstrated a "T" in the piping between a "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

j. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[2]

Claim Group 4 - Page 9

Appellant's arguments:

"Applicants believe that claim 7 is allowable for the same reasons that claim 1 is allowable. Further, claim 7 recites that the rate of the nonplasma diluent gas flow and the rate of the flow of plasma-activated reactive radicals have a ratio of at least 2:1. The Examiner alleges that Moslehi at

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[2]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

column 10, line 53-59 discloses this limitation. Applicants note, however, that the cited section in Moslehi describes the use of a digermane gas with halogen containing gas additives "through nonplasma gas manifold 22 (without any direct plasma discharge activation)" (col. 10, lines 55-51). Therefore, not only does Moslehi fail to disclose mixing a flow of reactive radicals and a nonplasma diluent gas flow anterior to the chamber to form a gas-radical mixture, but it does not teach or suggest the recited flow rate between the nonplasma diluent gas flow and the flow of plasma-activated reactive radicals."

Examiner's Response to Arguments:

k. *Appellant's argument that Moslehi does not teach the requisite flow ratio of nonplasma:plasma being 2:1 is precisely taught by Moslehi:

$$\frac{Nonplasma}{Plasma} = \frac{25{,}000.25sccm(column12, line1)}{100sccm(column11, line68)} = 250 >> 2$$

l. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[3]. The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining

[3]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

Claim Group 5 - Pages 9-10

Appellant's arguments:

"The Examiner alleges that the mixing point of the plasma and nonplasma gases in each of Kawamura and Moslehi is anterior to the wafer processing chamber.

Claim 8, from which claims 12 and 13 depend, recites a substrate processing apparatus which includes a process chamber, means for mixing a flow of reactive radicals and a nonplasma diluent gas flow downstream of the means for forming a plasma and anterior to the chamber to form a gas-radical mixture, and means for flowing the gas-radical mixture into the chamber.

Applicants respectfully assert that claims 8, 12, and 13 are novel and patentable over Kawamura and Moslehi because, for instance, they do not disclose or suggest means for mixing a flow of reactive radicals and a nonplasma diluent gas flow anterior to a chamber to form a gas-radical mixture, and means for flowing the gas-radical mixture into the chamber, as recited in claim 8 from which claims 12 and 13 depend.

In Kawamura, a pipe 32 is used to introduce "activated species, under a plasma excitation condition, into the chamber 10" (col. 3, lines 51-53), and a separate pipe 34 is used to introduce "Ar in a plasma phase or Ar ions in a plasma into the chamber 10" (col. 3, lines 59-60). There is no means

for mixing a flow of reactive radicals and a nonplasma diluent gas flow anterior of the chamber to form a gas-radical mixture.

In Moslehi, the "nonplasma gas manifold 22" is used to introduce nonplasma gases into the chamber (col. 11, lines 7-9). For a plasma process, "plasma activation can be achieved by injecting a remote plasma stream using the gases injected through plasma gas manifold 24" (col. 11, lines 29-32). As shown in Fig. 1, the nonplasma gas manifold 22 and the plasma gas manifold 24 have separate injectors into the chamber. Thus, there is no means for mixing a nonplasma diluent gas flow and a flow of reactive radicals to form a gas-radical mixture anterior to the chamber."

Examiner's Response to Arguments:

m. By Kawamura, plasma gas (column 5, lines 65-69) and a nonplasma inert gas (Argon, column 6, lines 15-17) mixed anterior at buffer chamber 30 (Figure 1) thus forming gas-radical mixture (responsive to first paragraph, Page 8, Paper 17). The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

n. By Moslehi, there is demonstrated a "T" in the piping between a "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). *Means for mixing a nonplasma diluent gas flow and a flow or reactive radicals (plasma) to form a gas-radical mixture anterior to the chamber* is identically taught by Moslehi according to the

"T" joining the plasma and nonplasma gases shown in Figure 1 (immediately under item 28). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

o. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[4]

Claim Group 6 - Page 10

Appellant's arguments:

"Applicants believe that claims 9, 14, and 15 are allowable for the same reasons that claim 8 is allowable. Further, claim 9 from which claims 14 and 15 depend recites that the nonplasma diluent gas flow comprises a nonplasma inert gas. In Kawamura, the Ar gas is not mixed with the plasma-activated species anterior of the chamber to form a gas-radical mixture. In Moslehi, the inert gases are plasma-activated with the digermane gas and additives and flowed into the chamber in one case, and are plasma-activated and flowed into the chamber separately from the nonplasma digermane gas and additives in the other case. There is no mixing of a nonplasma inert gas with reactive radicals to form a gas-radical mixture anterior of the chamber."

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[4]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

Examiner's Response to Arguments:

p. By Kawamura, plasma gas (column 5, lines 65-69) and a nonplasma inert gas (Argon, column 6, lines 15-17) mixed anterior at buffer chamber 30 (Figure 1) thus forming gas-radical mixture (responsive to first paragraph, Page 8, Paper 17). The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

q. By Moslehi, there is demonstrated a "T" in the piping between an inert "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

r. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[5]

Claim Group 7 - Page 10

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[5]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

Appellant's arguments:

"Applicants believe that claim 10 is allowable for the same reasons that claim 8 is allowable. Further, claim 10 recites that the rate of the nonplasma diluent gas flow and the rate of the flow of plasma-activated reactive radicals have a ratio of at least 2:1. The Examiner alleges that Moslehi at column 10, line 53-59 discloses this limitation. Applicants note, however, that the cited section in Moslehi describes the use of a digermane gas with halogen containing gas additives "through nonplasma gas manifold 22 (without any direct plasma discharge activation)" (col. 10, lines 55-51). Therefore, not only does Moslehi fail to disclose mixing a flow of reactive radicals and a nonplasma diluent gas flow anterior to the chamber to form a gas-radical mixture, but it does not teach or suggest the recited flow rate between the nonplasma diluent gas flow and the flow of plasma-activated reactive radicals."

Examiner's Response to Arguments:

s. *Appellant's argument that Moslehi does not teach the requisite flow ratio of nonplasma:plasma being 2:1 is precisely taught by Moslehi:

$$\frac{Nonplasma}{Plasma} = \frac{25{,}000.25sccm(column12, line1)}{100sccm(column11, line68)} = 250 >> 2$$

t. By Moslehi, there is demonstrated a "T" in the piping between an inert "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-

Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

Claim Group 8 - Page 11

Appellant's arguments:

"Applicants believe that claim 11 is allowable for the same reasons that claim 8 is allowable. Further, claim 11 recites that the nonplasma diluent gas flow comprises a reduction gas. Kawamura uses plasma-activated H* species, not a nonplasma reduction gas. In Moslehi, H_2 is plasma-activated with the remaining gases and flowed into the chamber in one case, and H_2 is introduced into the chamber via a nonplasma manifold separately from the plasma-activated inert gases in the other case. There is no mixing of a nonplasma reduction gas with reactive radicals to form a gas-radical mixture anterior of the chamber."

Examiner's Response to Arguments:

u. By Kawamura, *with regards to "Kawamura using plasma-activated H* species, not a nonplasma reduction gas" - it is well accepted in the art that plasma gases are in flux between ionization (plasma) and neutralization (nonplasma molecular species)

v. *By Moslehi, means for mixing a nonplasma diluent gas flow and a flow or reactive radicals (plasma) to form a gas-radical mixture anterior to the chamber* is identically taught by Moslehi according to the "T" joining the plasma and nonplasma gases shown in Figure 1 (immediately under item 28). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

Claim Group 9 - Page 11-12

Appellant's arguments:

"The Examiner alleges that Kawamura or Moslehi discloses everything in claims 16-20 except for the microwave arresters and apertures, and alleges that Stevens et al. discloses a microwave applicator using both an input aperture and output aperture with microwave arresters at column 9, lines 24-32.

Claim 16, from which claims 17-20 depend, recites a substrate processing apparatus which includes a plasma applicator defining an internal volume which has an input aperture and an output aperture equipped with microwave arresters, and a pump system which directs a nonplasma diluent gas flow and a flow of reactive radicals for mixing when traveling between the inlets and the outlet

of a mixing manifold to form a gas-radical mixture egressing from the outlet of the mixing manifold and traversing through an intake port of a process chamber.

Applicants respectfully assert that claims 16-20 are patentable over the cited references because, for instance, they fail to disclose or suggest a mixing manifold and a pump system to create a nonplasma diluent gas flow and a flow of the reactive radicals to the mixing manifold to combine the diluent gas flow and the flow of the reactive radicals to form a gas-radical mixture egressing from the outlet of the mixing manifold and traversing through the intake port of the chamber, as recited in claim 16 from which claims 17-20 depend.

As discussed above, Kawamura does not teach a mixing manifold for mixing a nonplasma diluent gas flow and a flow of reactive radicals, but discloses separately flowing activated species of NF_3/H_2 first and then an Ar gas into the chamber. In Kawamura, the pipe 32 is used to introduce "activated species, under a plasma excitation condition, into the chamber 10" (col. 3, lines 51-53), and the pipe 34 is used to introduce "Ar in a plasma phase or Ar ions in a plasma into the chamber 10" (col. 3, lines 59-60). In Moslehi, the "nonplasma gas manifold 22" is used to introduce nonplasma gases into the chamber (col. 11, lines 7-9), and "plasma activation can be achieved by injecting a remote plasma stream using the gases injected through plasma gas manifold 24" (col. 11, lines 29-32). As shown in Fig. 1, the nonplasma gas manifold 22 and the plasma gas manifold 24 have separate injectors into the chamber. Thus, there is no mixing manifold and a pump system to combine the diluent gas flow and the flow of the reactive radicals to form a gas-radical mixture egressing from the outlet of the mixing manifold and traversing through the intake port of the chamber. Applicants

further note that Stevens et al. does not teach the microwave applicator and apertures at column 9, lines 24-32 as alleged by the Examiner."

Examiner's Response to Arguments:

w. *Stevens et al discuss a microwave applicator (90) using both an input aperture (91) and output aperture (93) with microwave arresters (column 9, lines 24-32).

x. By Kawamura, plasma gas (column 5, lines 65-69) and a nonplasma inert gas (Argon, column 6, lines 15-17) mixed anterior at buffer chamber 30 (Figure 1) thus forming gas-radical mixture (responsive to first paragraph, Page 8, Paper 17) via a pump system (44, 46, 54; Figure 1) which directs these independent gas flows when traveling between the inlets (where pipes 32 - Not properly labeled and pipe 34 mix anterior to the chamber 10; Figure 1) and the outlets (28; Figure 1) of a mixing manifold (30, Figure 1) to form a gas-radical mixture "egressing" from the outlet of the mixing manifold and traversing through an intake port (28; Figure 1) of a process chamber (10; Figure 1). The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

y. By Moslehi, there is demonstrated a "T" in the piping between a "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). *Means for mixing a nonplasma diluent gas flow and a flow or reactive radicals (plasma) to form a gas-*

radical mixture anterior to the chamber is identically taught by Moslehi according to the "T" joining the plasma and nonplasma gases shown in Figure 1 (immediately under item 28). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

z. The examiner agrees that the Moslehi reference shows two separate injectors for plasma and nonplasma gas (Figure 1). However, the Moslehi reference also, as manifested by the "T" piping of Figure 1 combines a "Plasma" and "Nonplasma" gas mixture anterior to the process chamber. Thus, *a mixing gas manifold (item 20, Figure 1) and pumping system (item 30, Figure 1) are additionally described by Moslehi's apparatus and method where "a gas-radical mixture egressing from the outlet (24, Figure 1) of the mixing manifold and traversing through the intake port (24, Figure 1) of the chamber (14, Figure 1)". The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

aa. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[6]

Claim Group 10 - Pages 12-13

Appellant's arguments:

"The Examiner alleges that the mixing point of the plasma and nonplasma gases in each of Kawamura and Moslehi is anterior to the wafer processing chamber.

Claim 21 recites a method of removing residue from a substrate processing chamber. The method includes mixing a flow of reactive radicals and a nonplasma gas flow anterior to the chamber to form a gas-radical mixture, and flowing the gas-radical mixture into the chamber.

Applicants respectfully assert that claim 21 is novel and patentable over Kawamura and Moslehi because, for instance, they do not disclose or suggest mixing a flow of reactive radicals and a nonplasma gas flow anterior to a chamber to form a gas-radical mixture, and flowing the gas-radical mixture into the chamber in a method of removing residue from a substrate processing chamber.

As discussed above, Kawamura discloses flowing plasma-activated F*, H*, and N* species into the chamber, stopping the flow, and then feeding Ar gas into the chamber. There is no mixing of a flow of reactive radicals and a nonplasma gas flow anterior of the chamber to form a gas-radical mixture. In Moslehi, either both the digermane gas and additives and the inert gases flow through the plasma gas tube to produce a remote plasma stream of the gases into the chamber, or the non-plasma

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[6]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

digermane gas and additives are introduced into the afterglow of the inert gas plasma discharge in the, chamber. In each case, there is no mixing of a nonplasma gas flow and a flow of reactive radicals to form a gas-radical mixture anterior to the chamber. Therefore, claim 21 is novel and patentable over Kawamura and Moslehi."

Examiner's Response to Arguments:

bb. By Kawamura, plasma gas (column 5, lines 65-69) and a nonplasma inert gas (Argon, column 6, lines 15-17) mixed anterior at buffer chamber 30 (Figure 1) thus forming gas-radical mixture (responsive to first paragraph, Page 8, Paper 17). The anterior mixing point in the Kawamura apparatus is within the buffer chamber (item 30). This mixing point is separated from, and thus anterior to, the processing chamber (item 10).

cc. By Moslehi, there is demonstrated a "T" in the piping between a "Non-plasma" (Ar containing gas, items 22 & 20; Figure 1) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see below) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

dd. A method of residue removal is taught by Moslehi comprising:

ee. "Forming a flow of reactive radicals generated in a remote plasma (Figure 1; 28) outside of the chamber (Figure 1; 14)

ff. Forming a nonplasma gas flow (Figure 1; 22, and "T")

gg. Mixing the flow of reactive radicals and nonplasma gas flow anterior to the chamber to form a gas-radical mixture (see above) and flowing the radical mixture into the chamber". The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

hh. A method of residue removal is taught by Kawamura comprising:

ii. "Forming a flow of reactive radicals generated in a remote plasma (Figure 1; 32) outside of the chamber (Figure 1; 10)

jj. Forming a nonplasma gas flow (Figure 1; 34)

kk. Mixing the flow of reactive radicals and nonplasma gas flow anterior to the chamber to form a gas-radical mixture (see above) and flowing the radical mixture into the chamber

ll. Anterior - adj. 1 a: situated before or towards the front b: situated near or toward the head or part most nearly corresponding to a head 2: Coming before in time or development[7]

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[7]Merriam-Webster's Collegiate Dictionary, Merriam-Webster, Inc., 10th Ed. ©1998

Additional points:

mm. By Kawamura, a total pressure (comprising diluent gas and plasma gas) less than 1 Torr (column 4, lines 24-25, column 5, lines 63-64, column 6, lines 2-4)

nn. The dependance of the rate at which a chamber residue gas is exhausted compared to the rate of a diluent gas flow is implicitly described according to the geometry of the piping as described by Kawamura. Accordingly, Kawamura's chamber residue gas is exhausted depending on the rate of a diluent gas flow that arrives in the processing chamber. A common assumption in fluid dynamics is that most fluids are incompressible, and for a constant processing chamber pressure to be established, fluid continuity equations dictate that, at steady-state, the flow into the processing chamber must equal the flow from the processing chamber.

2. In response to appellant's argument that the references fail to show certain features of appellant's invention, it is noted that the features upon which appellant relies, specifically, "...producing the gas-radical mixture anterior of the chamber allows increasing the flow rate of a gas through the chamber, while decreasing the rate at which materials located within the chamber are etched by the reactive radicals dispersed within the gas-radical mixture (page 4, lines 15-18)." are not recited in the rejected claims. Although the claims are interpreted in light of the specification,

limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

3. Appellant's arguments filed September 12, 2000 (paper 17) have been fully considered but they are not persuasive. Specifically, the appellant's argument that Moslehi does not disclose or suggest a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture (page 8, paper 17) is inaccurate. As cited in the second action on the merits, Moslehi describes a low temperature in-situ dry cleaning etching apparatus and method with the use of a gas (column 1, lines 13-24). Specifically, the limitations set forth in the rejected claims are explicitly detailed by Moslehi:

oo. Remote plasma formation (column 9, lines 6-10) relative to substrate processing chamber (Column 9, lines 10-17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

pp. Total pressure (comprising diluent gas and plasma gas) less than 1 Torr (column 3, lines 16-20)

qq. *Moslehi clearly demonstrates a "T" in the piping between a "Non-plasma" (item 22) and a "Plasma" gas stream (Figure 1) thus teaching "a method for mixing a flow or reactive radicals and a diluent gas flow anterior to a chamber to form a gas-radical mixture" (responsive to paragraph 2, Page 8, paper 17). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is

separated from, and thus anterior to, the processing chamber (item 14). The Merriam-Webster's Collegiate Dictionary definition of "anterior" (see above) supports the application of the Moslehi reference to the stated rejection. The anterior mixing point in the Moslehi apparatus is within the discharge cavity (item 28) as noted from the "T" joining plasma and nonplasma gases. This mixing point is separated from, and thus anterior to, the processing chamber (item 14).

rr. *Hydrogen is not plasma activated as identically taught by Moslehi (column 10, lines 53-59)

ss. Fluorinated gases (column 4, lines 31-36)

tt. Relative gas flow rates for the diluent gas (hydrogen) and the plasma forming gas (Ge_2H_6) meeting the claim 7 limitation is explicitly met (column 10, lines 53-59)

uu. For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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